MEC HA Framework Option Paper #4: Structure and Output

1.0 INTRODUCTION

This paper discusses options for the remaining two elements of the MEC HA framework: the structure and the output. Two options for the framework structure have been described, based upon the structures used in existing methods. The advantages and limitations of each approach are discussed, and a recommendation is made. Options for the framework output are discussed in the context of the recommended structure. Finally, a path forward to the development of the MEC HA framework is presented.

2.0 OPTIONS FOR THE FRAMEWORK STRUCTURE

The MEC HA framework structure consists of the methods used to:

- Assign scores to the values of individual input factors, based upon the level of hazard reflected by those values.
- Assign weights to the individual input factors that reflect the contribution the factor makes to the overall hazard level of a site.
- Combined the weighted scores of the input factors to determine the relative level of hazard for the site.

The methods used to score, weight and combine input factors are described for two potential structures:

- A relative numeric structure, similar to the structure used by the MRSPP.
- A matrix categorical structure similar to the structure used by the Adak ESHA and other similar IR3M-based methods.

The advantages and limitations of each approach are also discussed.

2.1 Relative Numeric Structure[1]

A numeric structure is currently in use for the Munitions Response Site Prioritization Protocol. Numeric structures typically have the following characteristics.

1. Scoring: Numeric scores are assigned to each value of each input factor; the higher the hazard for the value, the higher the assigned number.
2. Weighting: The weight assigned to each input factor is the highest possible value for the factor divided by the sum of highest possible values for all factors. For example, in the MRSPP, the highest possible sum of scores is 100, so the weight for each factor can be seen to be the maximum possible score for each factor – e.g., the maximum score for the MRSPP "munition type" factor is 30, so the weight for that factor is 30%.

[1] This description is based on the structure of the EHE module of the MRSPP as described in 32 CFR Part 179, as published in the *Federal Register*, vol. 68, No. 163/Friday, August 22, 2003/Proposed Rules.

3. Combination: Scores are summed to produce final numeric score, which is then mapped to one of several hazard categories. See attachment 1 for a description of the manner in which the MRSPP scores are mapped to Explosive Hazard Categories.

2.1.1 Advantages:

- **Communication and Transparency**: Use of numeric scoring and weighting enhances communication in several ways. First, it allows easy comprehension of the influence of each input factor on the final resulting score. Second, by facilitating understanding of the influence of the input factors, it ensures a transparent system.
- **Sensitivity:** Use of numeric scores is likely to allow a greater understanding of the impact of different alternatives on the hazard at the site. A numeric continuum is created that may more accurately reflect site-specific conditions.
- **Consistency:** The transparency of understanding of the manner in which the structure works will promote this consistency.
- **Flexibility in System Design:** The test phase of the system design will be easier to manage. The entire approach allows great flexibility in determining appropriate scores for input factor values and weights for input factors. Different numeric scores can be altered and evaluated without significantly changing the system. The sensitivity of the test results to different scores and weighting can be reviewed and evaluated with greater ease.
- **Consistency with the MRSPP:** Since this is the structure used in the MRSPP, use of this approach would assist in maintaining compatibility between the MEC HA and the MRSPP. Numeric scores and weights in the MRSPP could be evaluated for application to the MEC HA, as at least an initial point of departure.

2.1.2 Limitations:

- **Communication**: Use of numeric scores may imply to the user or the public a level of precision that is not intended or possible given that the input factors are mostly qualitative and the intended output is a dimensionless "index" of relative explosive hazard. This could present a communication challenge.
    - Since it is the desire of the workgroup to assign the results of the HA to "bins" or groups that describe the overall hazard of the group (and support understanding of the qualitative nature of the assigned hazard) it is assumed that cut-off scores will be assigned such that a group of numbers (e.g. 80-100) will be assigned to one hazard category. These categories could either be descriptive (e.g. high hazard) or alphabetical (e.g. A-E). This is similar to what is currently proposed for the MRSPP.

- **System design:** Consensus on the application of specific weights to different scoring factors may be difficult, as evidenced by the comments associated with the MRSPP.

2.2 Matrix Categorical Structure[2]

A second approach to the structure of the MRSPP is the use of a matrix categorical structure. This structure is used in several site-specific MEC HA processes (Fort Ord), as well as the USACE OERIA methodology.

1. Scoring: For each input factor, values are assigned alphabetical scores, with a score of "A" given to the least hazardous value.
2. Weighting: Input factors are assigned relative weights ("high", "moderate" or "low").
3. Combination: Two different approaches to combining input factors have been used:
   a. OERIA process – asks the project team to determine the overall ranking of the variety of factors considered for each category based on their assessment of the impact. This is a qualitative assessment that does not appear to include specific scoring rules.
   b. ADAK ESHA process -- Two to three low-level input factors (termed sub-factors or components) are combined based on relative weights into higher level factors with scores selected from two- or three-dimensional matrices. Resulting combined factors are again assigned relative weights and combined until a final letter score is produced. An example matrix from the Adak ESHA is attached.

2.2.1 Advantages:

- OERIA process – The approach has been used by the USACE for a number of years. Its application is not complex, and is easy to **communicate.**
- More Complex Matrix Approach –
  - This approach has been successfully applied to at least two sites (Adak and Ft. Ord)
  - The approach supports a reasonable amount of **Sensitivity, Accuracy and Representativeness**

2.2.2 Limitations:

- OERIA process – The use of this type of process fails on several important criteria:
  - **Transparency:** The team-specific judgment required to combine the factors makes understanding of the manner in which the final score is achieved difficult.
  - **Consistency:** Flexibility in structure and decision-making make the decisions of one project team difficult to replicate

- More Complex Matrix Approach
  - **Communication and Transparency: Determination** of hazard level requires interpretation of a series of complex tables. The relative influences of individual input factors are obscured by the complex organization of the structure. This approach has proven to be neither **transparent**, nor easy to **communicate,** even within the team. Communication and transparency issues

[2] This description is primarily based on the Adak ESHA method as documented in *Adak Island Operable Unit B Explosives Safety Hazard Assessment Methodology, Draft Version 11,* January 26, 2001.

could, however, be addressed within the guidance document, for example, with a sensitivity analysis discussion
  - **Sensitivity:** It may be more difficult to discern the effects of different response alternatives when using alphabetical categories alone.
  - **System design:** Testing of the application, and adjustments to scoring rules will be complex. Whereas testing of numeric scores lends itself to a sensitivity analysis of the sensitivity of the scoring process to the assignment of different weights, testing of categorical assignments without numbers is more challenging.

3.0 RECOMMENDED OPTION

Consensus was reached that the Relative Numeric Structure be used for the MEC HA. The greater flexibility of this method will simplify the development of the MEC HA framework. The **transparency** of the structure will make the application of the input factors easier to **communicate** both inside and outside of the project team. Although work will have to be done to ensure that stakeholders understand that all the numbers within a “bin” or hazard category are to be considered relatively the same, this will likely be easier to communicate than the complex matrix approach. Work previously done on the MRSPP, and comments on that work should facilitate understanding of stakeholder concerns with regard to scoring and weighting.

3.1 Output Options

MEC HA output will be based on categories of hazard (called “bins” during the discussion), as opposed to individual relative rankings of sites within a munitions response area or installation. Use of the Relative Numeric approach will also provide greater flexibility in the identification and definition of these categories. The numeric approach will also increase the usefulness of the MEC HA for evaluating individual sites, as well as prioritizing multiple sites within a facility.

3.2 Recommended Path Forward

Based on the discussions to date, and the analyses presented in the current and two previous framework option papers, the following approach will be used to complete the development of the MEC HA framework:

1. Finalize the selection of input factors and develop comprehensive sets of values for each of the selected input factors.
2. Agree on the relative contribution of each of the three components of explosive hazards to the overall explosive hazard severity of a site. Translate this agreement into proportional weights for each of the components. The three components are:
   a. The potential severity of the impact to a receptor or receptors should an MEC item function.
   b. The likelihood that a receptor will be able to interact with an MEC item.
   c. The likelihood that the item will function if a receptor interacts with it.

3. For each component, agree on the relative contribution of the applicable input factors to the hazard severity of that component. Translate these agreements into proportional weights for each of the individual input factors.
4. Develop numeric scores for each input factor value, based on the hazard represented by each value and the proportional weights determined in the previous step.
5. Perform functionality tests of the resulting MEC HA framework to ensure:
    a. That the outcomes of all possible combinations of input factor values are reasonable.
    b. That the resulting possible scores can be easily mapped into categories (in other words, the resulting scores aren’t all clustered around one or two values).

During this process, it is important to remain cognizant of the effect that scoring and weighting decisions will have on the input to be provided to subsequent hazard management decisions, especially those regarding response alternative selection and land use decisions. Use of the Relative Numeric Structure will facilitate identification of these effects, and provide the flexibility to make adjustments as deemed necessary.

Attachment 1: Example MRSPP Scoring Matrix

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TABLE 2.—CLASSIFICATIONS WITHIN THE EHE MODULE SOURCE OF HAZARD DATA ELEMENT

Classification	Description	Score
Former range	• The MRS is a former military range where munitions (including practice munitions with sensitive fuzes) have been used. Such areas include: impact or target areas, associated buffer and safety zones, firing points, and live-fire maneuver areas.	10
Former munitions treatment (i.e., OB/OD) unit.	• The MRS is a location where UXO or DMM (*e.g.*, munitions, bulk explosives, bulk pyrotechnic, or bulk propellants) were burned or detonated for the purpose of treatment prior to disposal.	8
Former practice munitions range	• The MRS is a former range on which only practice munitions without sensitive fuzes were used.	6
Former maneuver area	• The MRS is a former maneuver area where no munitions other than flares, simulators, smokes, and blanks were used. There must be evidence that no other munitions were used at the location to place an MRS into this category.	5
Former burial pit or other disposal area	• The MRS is a location where DMM were buried or disposed of (*e.g.*, disposed of into a water body) without prior thermal treatment.	5
Former industrial operating facilities	• The MRS is a location that is a former munitions manufacturing or demilitarization facility.	4
Former firing points	• The MRS is a firing point, when the firing point is delineated as an MRS separate from the rest of a former range.	4
Former missile or air defense artillery emplacements.	• The MRS is a former missile defense or air defense artillery (ADA) emplacement not associated with a range.	2
Former storage or transfer points	• The MRS is a location where munitions were stored or handled for transfer between modes (*e.g.*, rail to truck, truck to weapon system).	2
Former small arms range	• The MRS is a former military range where only small arms were used. There must be evidence that no other type of munitions (*e.g.*, grenades) were used or are present at the location to place an MRS into this category.	1
Evidence of no munitions	• Following investigation of the MRS, there is physical evidence that no UXO or DMM are present, or there is historical evidence indicating that no UXO or DMM are present.	0

Notes:
• Former (as in "former range") means the MRS is a location that was: (1) closed by a formal decision made by the DoD Component with administrative control over the location, or (2) put to a use incompatible with the presence of UXO, DMM, or MC.
• Historical evidence means that the investigation: (1) Found written documents or records, or (2) documented interviews of persons with knowledge of site conditions, or (3) found and verified other forms of information.
• Physical evidence means: (1) Recorded observations from on-site investigations, such as finding intact UXO or DMM, or components, fragments, or other pieces of military munitions, or (2) the results of field or laboratory sampling and analysis procedures, or (3) the results of geophysical investigations.
• Practice munitions means munitions that contain an inert filler (*e.g.*, wax, sand, concrete), a spotting charge (*i.e.*, a pyrotechnic charge), and a fuze.
• The term small arms ammunition means solid projectile ammunition that is .50 caliber or smaller and shotgun shells.

Attachment 1(a) Application of Overall Scoring to EHE Rating

TABLE 10.—DETERMINING THE EHE RATING FROM THE EHE MODULE SCORE

Overall EHE Module Score	EHE Rating
The MRS has an overall EHE module score from 92 to 100	EHE Rating A
The MRS has an overall EHE module score from 82 to 91	EHE Rating B
The MRS has an overall EHE module score from 71 to 81	EHE Rating C
The MRS has an overall EHE module score from 60 to 70	EHE Rating D
The MRS has an overall EHE module score from 48 to 59	EHE Rating E
The MRS has an overall EHE module score from 38 to 47	EHE Rating F
The MRS has an overall EHE module score less than 38	EHE Rating G

Attachment 2: Example Matrix Scoring Table from the Adak ESHA

Table 4.4-6 Public Exposure Weighting Factors and Scoring Rules [1,2]

- **Frequency of Public Access - High Weighting**
- **Intensity of Public Activity - High Weighting**
- **Portability - Low Weighting**

	PORTABILITY								
	A Very Low			B Low			C Easily Portable		
Intensity of Public Activity (Energy Imparted to the Ground) ➔ Frequency of Public Access 🡻	A Low	B Moderate	C High	A Low	B Moderate	C High	A Low	B Moderate	C High
A Least Frequent	A	A	B	A	A	B	A	A	B
B Less Frequent	A	A	B	A	B	B	A	B	C
C Nominal	B	B	B	B	C	C	B	C	D
D More Frequent	C	C	C	C	D	D	C	D	D
E Most Frequent	C	D	D	D	E	E	D	E	E

NOTES:

[1] The scoring for the Public Exposure Hazard Factor is primarily weighted toward (determined by) the Frequency of Public Access, with relatively minor adjustments are made to reflect the Intensity of the current or projected future Public Activities (with respect to imparting energy to the ground) and the Portability of the energetic ordnance items found in the area.

[2] Description of Ordnance Accessibility Scoring Factors:

- Scores for the "Least Frequent" category of Frequency of Public Access (for all categories of Intensity of Public Activity and Portability) are A, unless the Intensity of Public Activity is "High" in which case the score is B
- Scores for the "Less Frequent" category of Frequency of Public Access (for all categories of Intensity of Public Activity and Portability) are A, unless the Intensity of Public Activity is at least "Moderate" and the Portability is "Low" (B) or "Easily Portable" (C)
- Scores for the "Nominal" category of Frequency of Public Access (for all categories of Intensity of Public Activity and Portability) are B, unless the Intensity of Public Activity is at least "Moderate" and the Portability is "Low" (C) or "Easily Portable" (D)
- Scores for the "More Frequent" category of Frequency of Public Access (for all categories of Intensity of Public Activity and Portability) are C, unless the Intensity of Public Activity is at least "Moderate" and the Portability is "Low" (D) or "Easily Portable" (E)
- Scores for the "Most Frequent" category of Frequency of Public Access (for all categories of Intensity of Public Activity and Portability) are D, unless the Portability is at least "Low" and the Intensity of Public Activity is at least "Moderate", in which case the score is E
- If the Intensity of Public Activity is "Low" for cases where the Portability is "Very Low", the score for "Most Frequent" category of Frequency of Public Access is C